RISK-BASED ANALYSIS OF BRIDGE SCOUR PREDICTION WITH LIVE BED CONDITIONS

First year workout

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Outline

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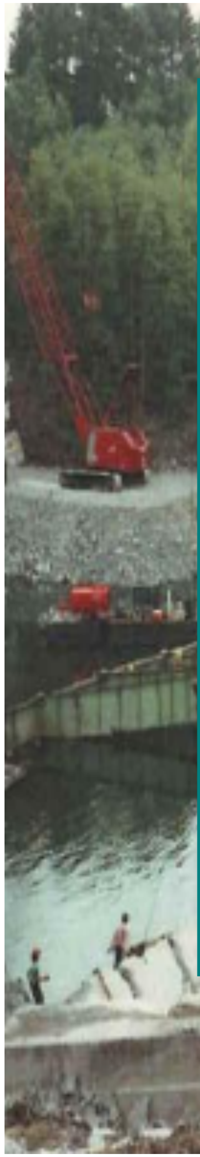
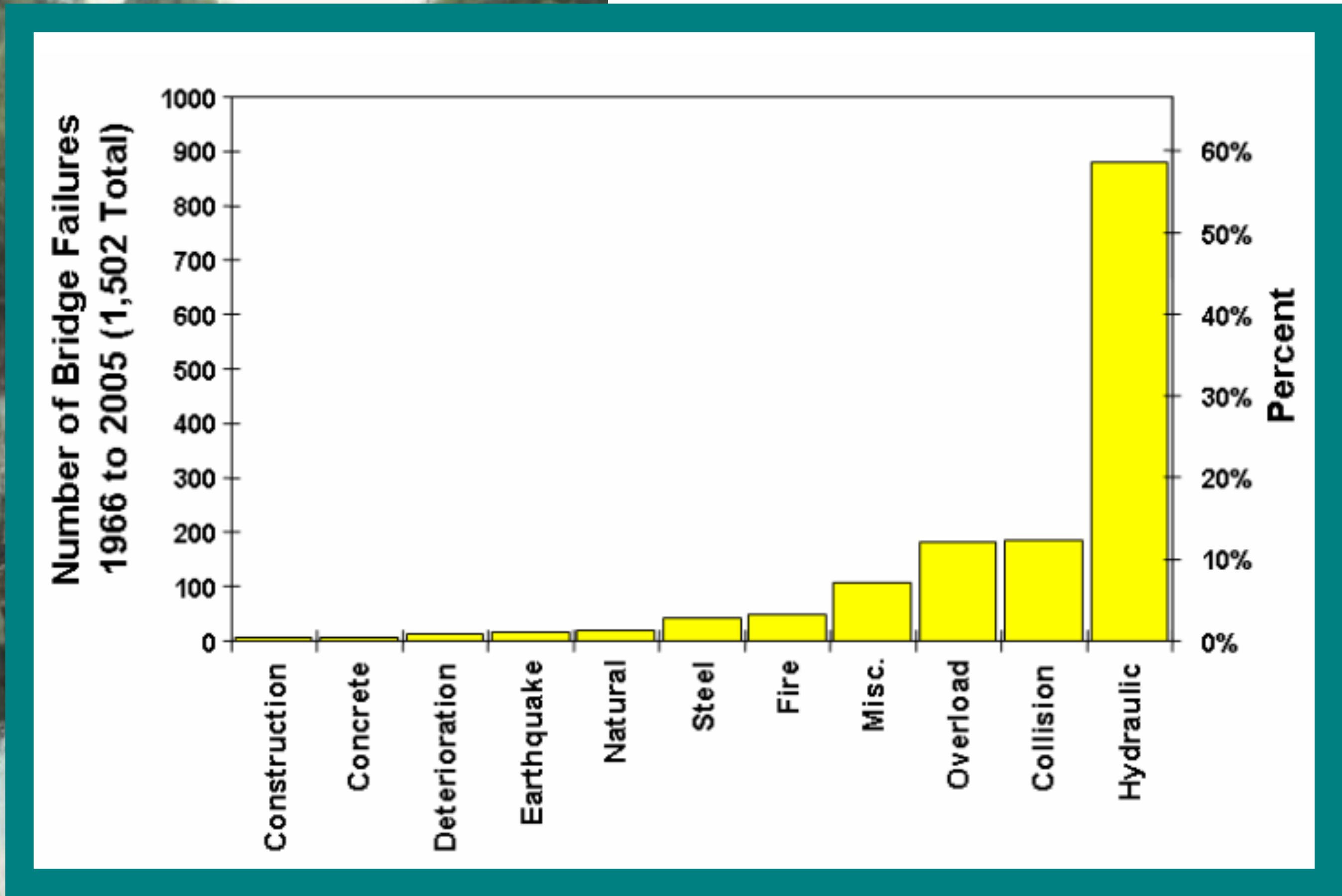
1. Motivation



Schoharie Creek bridge, NY, USA, 1987



• Flood warning action plan

1. Motivation

Hintze Ribeiro bridge, Portugal, 2001

PORTUGAL

1983: Partial collapse of the Penacova bridge

1994: Structural failure of Gafanha bridge, in Aveiro

2001: Displacement of the bridge abutment of bridge over Sorraia river causing its failure

The most recent and hazardous case of scour, registered in Portugal, occurred in **2001** with the collapse of the **Hintze-Ribeiro bridge**, causing **59 casualties**.

….from a brief literature review

Flood, Scour and other hydraulic events are the most common causes of bridge collapses!

Johnson et al. (2015) developed a risk/reliability-based methodology to be used in calculating bridge pier, linking scour estimates to a probability; always using a 100-year return period for the hydrologic event.

However,

Flint et al. (2017) showed that scour-induced collapses were associated with return periods lower than 100 years.

Thus,

…there is still a lot of improvements to make in this field, particularly in **placing most hydrologic and hydraulic facets** of bridge design at similar levels of reliability as structural and geotechnical facets.

2. Objectives

Develop a **risk-based method** for **predicting** the likely **bridge scour** under **live bed** conditions

Case studies

Establish relationships between flow duration curves and flood hydrographs probability

Laboratory work

Extract functional relations between flood scenarios and scouring effects

Data for calibration and validation

CFD modelling

Evaluate the prediction of scouring process by readily available CFD tools

Application to real Portuguese bridges

3. Approach and Methodologies

Case studies:

Typical bridge piers geometry - XIX century

Streamflow data – typically a sequence of flow peaks **[2,3,4]**

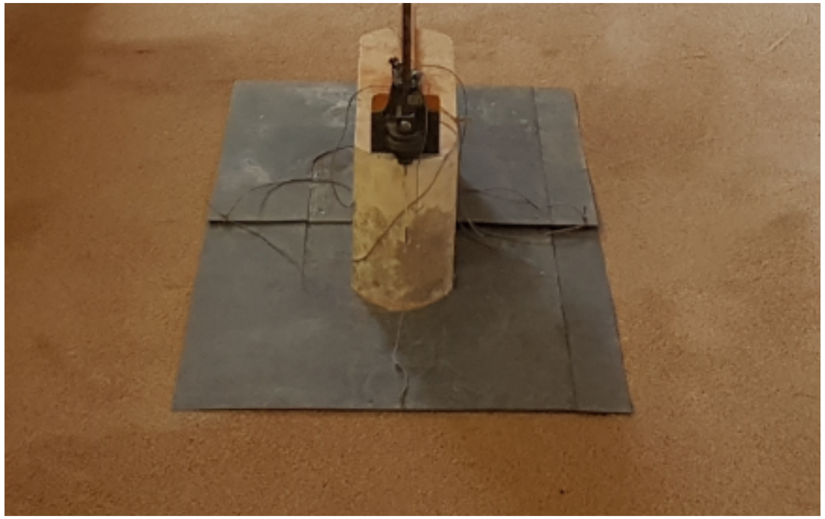
Bathymetry and granulometry – site specific

Laboratory work:

Column bridge pier

Hydrographs of different shapes and durations under clear water and live bed scour conditions **[5]**

Sand characteristics: uniform sand bed (σ_d = 1.4, D_{50} = 0.86 mm)



4. Work Done

A) Completion of the academic curricular **courses**:

- **Uncertainty / Risk and Reliability** courses: 10 credits
- Courses units **at FEUP**: 10 credits

B) Compilation of the **literature review:**

- Bridge scour processes
- Uncertainty and reliability methodologies in bridge scour estimation
- Research techniques for both laboratory and numerical environments

C) Collection of **real cases** data:

- Contacts with Infrastructures of Portugal (IP)
- Bathymetry, granulometry and streamflow data

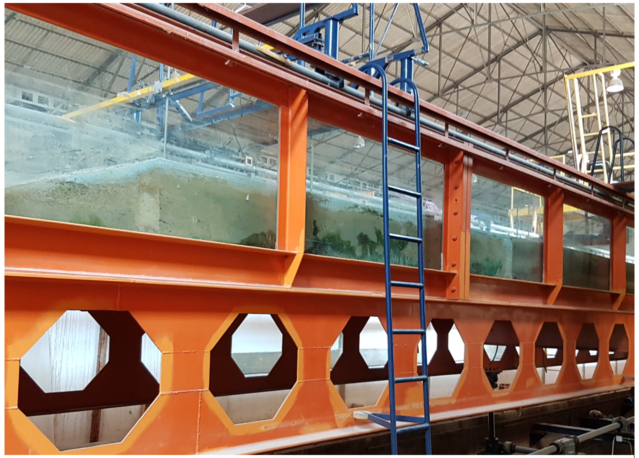
5. Work in Progress (1/2)

D) **Laboratory** work:

- Adaptation of the tilting flume (CIV), at Fluvial Hydraulics Pavilion of LNEC

- Trial runs of experimental methodologies

Experiment 1



Flume at LNEC
(40 m long and 2 m wide)

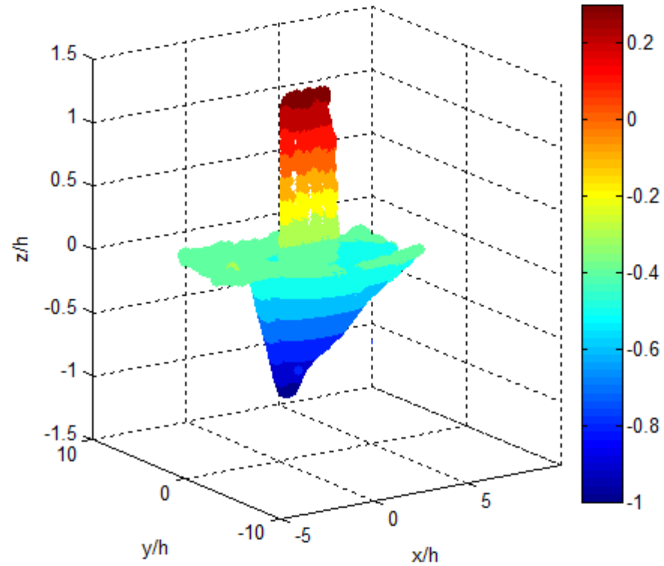
Scour hole at pier vicinity
(L = 14 cm; ds = 23 cm - 3 days)

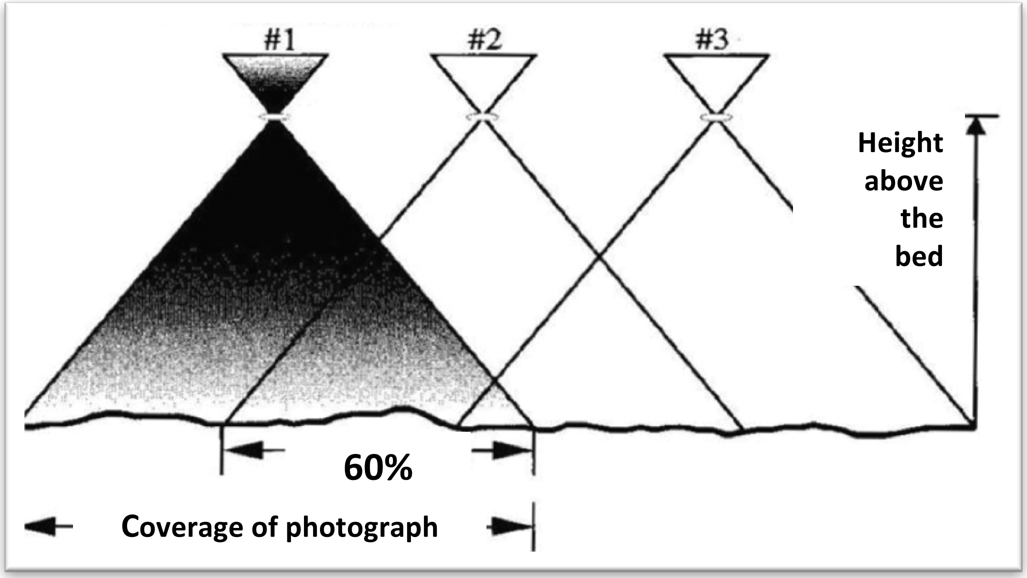
5. Work in Progress (2/2)

- Analysis of first experimental results

Point-wise measurements

3D characterization of the scour hole





6. Future Developments

E) **Case studies**:

- Selection of real case studies
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  design criteria
- Establishment of the risk failure for such structures

I) **Publishing:**

- Conference and jornal papers
- PhD thesis writing

	2016/17		2017/18		2018/19		2019/20	
Tasks	**1S**	**2S**	**1S**	**2S**	**1S**	**2S**	**1S**	**2S**
A) Courses	X	X						
B) Literature Review	X	X						
C) Real cases	X	X						
D) Laboratory		X	X	X				
E) Case studies			X	X				
F) Experiments			X	X				
G) Numerical m.				X	X	X	X	X
H) Risk analysis					X	X	X	X
I) Publishing			X	X	X	X	X	X

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7. Main references

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Thank you!

The research work was supported by the Portuguese Foundation for Science and Technology (FCT), through the PhD scholarship PD/BD/127798/2016, in the framework of the Doctoral Program INFRARISK – Analysis and Mitigation of Risks in Infrastructures.